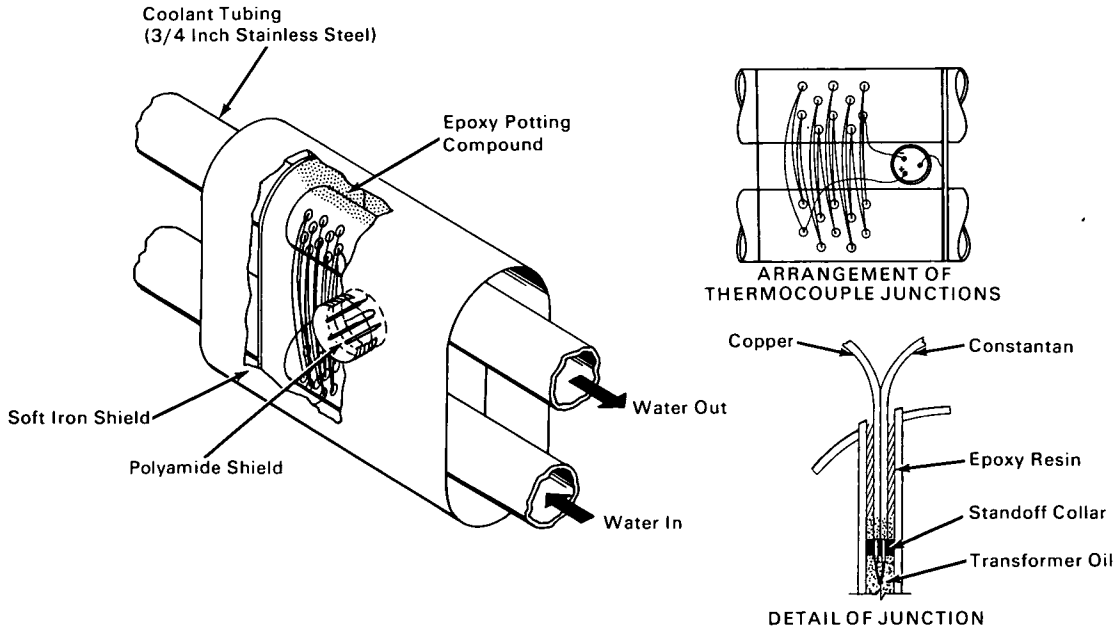
NASA TECH BRIEF

Transducer Measures Temperature Differentials in Presence of Strong Electromagnetic Fields



The problem: Accurately measuring the temperature rise of cooling water at pressures exceeding 1000 psi in electric-arc heaters. A temperature transducer used in the environment of such heaters would have to be insensitive to multimegawatt electrical discharges emitting random-frequency radiation through a spectrum from 0 to 40 kc, voltages induced by neighboring magnetic fields, and stray electric currents in the cooling water. In addition, the instrument must respond rapidly to small differential temperatures and deliver a signal not requiring external amplification.

The solution: A magnetically shielded thermopile with interconnecting wires of small loop area to minimize electromagnetically induced voltages. The thermocouple junctions are immersed in an oil-filled well to isolate them from the stray electric currents in the cooling water.

How it's done: The transducer consists of a 20-junction thermopile mounted within a pair of large diameter (3/4-inch) stainless steel coolant tubes by means of 20 individual hypodermic tubing wells. The junctions are arranged so as to minimize the area of the loop formed by the interconnecting wire and thus minimize electromagnetically induced voltages. This arrangement also ensures adequate sampling of bulk stream temperatures of the water under turbulent flow conditions. The entire assembly is encapsulated in epoxy resin and encased in a soft-iron sheath which is electrically connected to the coolant tubes to form a complete magnetic shield around the thermopile. Ten

(continued overleaf)

"hot" junctions and ten "cold" junctions are connected in series to obtain a tenfold multiplication of the thermoelectric signal. Each junction is immersed in an oil-filled well to isolate it electrically from the water and hermetically sealed with an epoxy resin.

The output is taken from two terminals of a 3-pronged connector which is electrically isolated from the soft iron casing. The plug terminates one end of a length of 2-conductor shielded cable which carries the output signal to a current-sensitive galvanometer-type recorder. The electromagnetic shielding is made continuous by connecting the iron casing to the cable shielding via the third prong. The entire instrument measures approximately 6×3×1 1/2 inches.

Notes:

1. This instrument would be useful for measuring temperature differentials of most coolant fluids subjected to strong electromagnetic fields and stray electric currents.
2. Further information concerning this invention is described in a paper entitled, *Measuring Temperature in Strong Fields*, by David Wald, in Instruments and Control Systems, V. 36, No. 5, May 1963. Inquiries may also be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California, 94035
   Reference: B65-10089

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA, and a patent application has been filed. Royalty-free nonexclusive licenses for its commercial use are available. Inquiries concerning license rights should be made to NASA, Code AGP, Washington, D.C. 20546.

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